SUPER-PLANES

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SUPERPLANES

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SUPERPLANES

John Gabriel Navarra

DOUBLEDAY & COMPANY, INC.
GARDEN CITY, NEW YORK

This book is part of a Museum of Science & Industry/Chicago series of science books published by Doubleday & Company, Inc. The series is designed to inform, stimulate, and challenge youngsters on a wide range of scientific and technological subjects.

Library of Congress Cataloging in Publication Data

Navarra, John Gabriel.
Superplanes.

Includes index.
SUMMARY: Describes various types of planes used throughout the world and their various uses, from trade and cargo to passenger and space travel.
1. Airplanes—Juvenile literature. [1. Airplanes]
I. Title.
TL547.N36 629.133′34
ISBN 0-385-12561-5 Trade
0-385-12562-3 Prebound
Library of Congress Catalog Card Number 77-16936

Design by Celeste Navarra

Printed in the United States of America
First Edition

PREFACE

Oceans and mountains are no longer significant barriers to travel. In this age of jet aircraft the time it takes to cross such barriers is not very significant. Today it is possible to reach any location on this planet of ours in less than twenty-four hours.

The high-speed transportation of jet aircraft is available to almost everyone. Each day commercial airlines carry more than one-half million people on giant subsonic aircraft. High-performance military aircraft are streaking across the sky at twice the speed of sound. And commercial supersonic transports are carrying passengers from continent to continent.

Our present world-wide transportation network would not be possible without jet aircraft. The airplane is an important part of our social, political, and economic life. In this book you will find information about some of the aircraft used in commercial and military aviation. In addition, you will find a section that details the use of aircraft for special purposes such as weather forecasting, astronomical observation, and surveying.

JOHN GABRIEL NAVARRA

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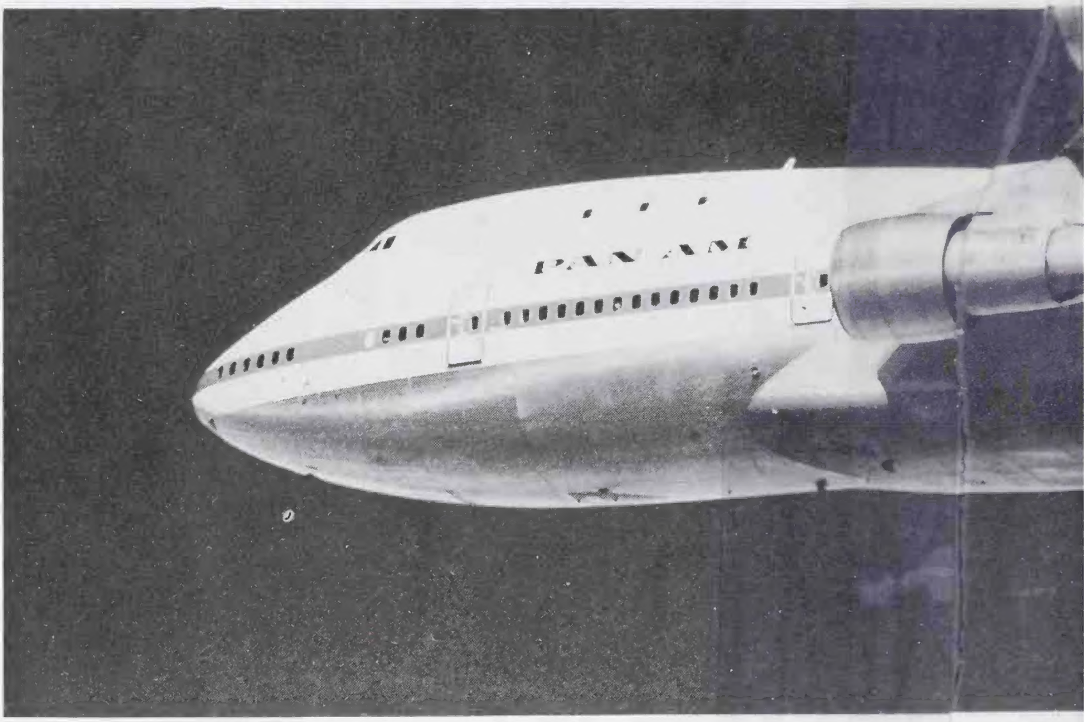
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PART 1

Commercial Aircraft

Today the airline industry is large and varied. If you want to fly nonstop from New York to San Francisco, you can make a reservation on any of a number of domestic commercial airline flights. An around-the-world tour is arranged through an international commercial airline.

Much of the success of an airline stems from the careful selection of the aircraft it uses. Other things being equal, airline passengers favor the airline that gets them there first. Speed is one of the factors in attracting passengers. There is a constant race among the airlines to be the first with newer, larger, and faster planes.

The design of an airliner evolves slowly. It is usually a compromise between what several airlines want. The present realities also play an important part in the design of a commercial airliner. For example, the sudden jump in the cost of jet fuel has made a lot of the aircraft currently flying too costly. And other aircraft are too noisy to meet the new environmental rules! The airliner of the future must be quiet and it must be economical to fly.

1

A BRIEF HISTORY

Scheduled commercial aviation began on April 6, 1926. On that historic day, the small Swallow biplane—shown in the photo below—lifted into the air at Pasco, Washington, and flew toward Elko, Nevada, 487 miles away. The cargo on board was sixty-four pounds of mail.

Interest in flying was high in the 1920s. People wanted to go along as passengers on the mail planes. The only space available for a passenger, however, was in the open cockpit along with the mail sacks!

The first airplane designed for passengers had a forward cabin. But the pilot flew in an open cockpit. Passengers are in the process of boarding the Boeing 40B-4 shown in the upper photo opposite. There was space for four passengers in the forward cabin area between the wings. The Boeing 40B-4 was in service in 1926. It soared along at 110 miles per hour.

The forerunner of the all-metal airliner was the sleek

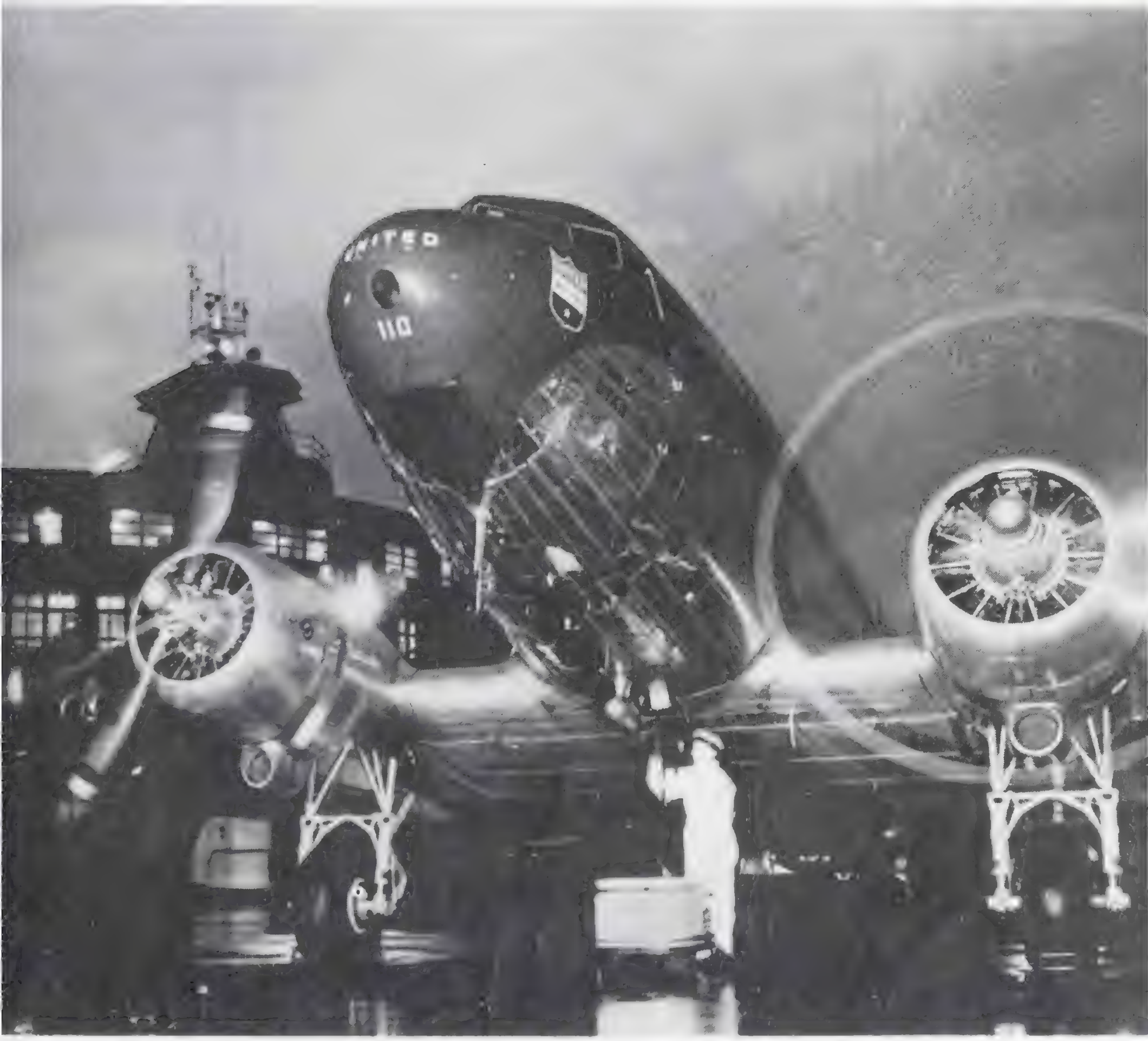
Boeing Monomail. This single-engine plane had cabin space for passengers just forward of the open cockpit. The Monomail—shown in the lower photo on page 11—had retractable landing gear.

By 1930, the Boeing 80A, a tri-engine plane, was the last word in comfort. It featured cushioned seats and wide windows. Twelve passengers traveled in relative comfort between San Francisco and Chicago on the flight shown in the photo above.

In the photo, the Boeing 80A is flying just north of Chicago's Loop. The Chicago of today is quite different from the Chicago of 1930. But some familiar landmarks can be seen in the photo. In the background at the upper left you can see the Wrigley Building and Tribune Tower.

The first Douglas DC-3 was flown on December 17, 1935. The DC-3 became the workhouse of the airlines. It was the first airliner capable of earning a profit carrying only passengers. The industry put these planes into service as fast as they could be produced. More than 10,000 DC-3s were built and about 1,000 are still in service throughout the world.

The DC-3 shown below was designed for twenty-one passengers. It has a wingspan of 95 feet and a length of almost 65 feet. A maximum speed of 230 miles per hour is developed at 9,000 feet. The DC-3's cruising speed is 155 miles per hour. It has a range of 1,300 miles and a service ceiling of 29,000 feet.



2

THE JET AGE

Air transportation was revolutionized when jet aircraft replaced piston-driven planes. The graceful French Caravelle with twin engines mounted aft made its first flight in 1955. On July 14, 1961, the speedy Caravelle—shown in the photo below—was the first two-engined jet to enter service within the United States. It was used on short-to-medium-range flights—especially the Chicago to New York run.

A return to American built tri-motor aircraft was made when Boeing introduced its 727. The three powerful fanjet

engines of the Boeing 727 are nestled at the rear of the airplane. This sleek 600-mile-per-hour jet can carry from 96 to 113 passengers on short-to-medium-range flights.

Three other entries in the tri-motor class can be seen on page 16. They are Lockheed's L-1011 Tristar, the Hawker Siddeley Trident, and the Douglas DC-10. The Tristar—shown in the lower right photo—is capable of carrying more than 250 passengers. The DC-10, called an airbus, is a fat-fuselage plane that is 20 feet wide. The


UNITED


TWA

airbus—shown in the lower left photo—can cruise at 600 miles per hour and carry more than 300 passengers for distances of 3,000 miles. The Trident—shown in the upper photo on page 16—is a large-capacity, short-range aircraft. The British Trident can carry up to 180 passengers over a range of 1,500 miles.

On long hauls, the workhorse jets of the 1960s were the Boeing 707s and the Douglas DC-8s. But fuel and other operating costs skyrocketed during the 1970s. And as a result, airlines found that they needed to fill more than 60 percent of the seats on these planes just to break even. In the competitive market of today, especially on international flights, it is difficult for these older aircraft—the DC-8 shown above, for example—to make money for their operators.

In order to hold costs down and increase profits, the airlines have turned to the jumbo jets. The long-haul workhorse of today is the Boeing 747. It is an aircraft that is very efficient.

The 747 can carry up to 490 passengers. The 231-foot-long craft cruises at 625 miles per hour, and it has a range of more than 5,000 miles. The 747 can weigh up to 712,000 pounds at takeoff.

The 747's cabin is 20 feet wide and nearly 186 feet long. It is partitioned into five sections, which gives a passenger the feeling of being seated in a small theater. Movies are shown on screens in each section.

Economy seating is nine abreast with two aisles. Each aisle is 20 inches wide, which is sufficient to permit passengers to move about. First-class seating is four abreast with one center aisle. There are six galleys for preparing and serving food, and there are twelve lavatories for the convenience of the passengers.

The 747's wingspan is 195 feet. A single wing on this giant jet weighs 28,000 pounds. And the wing area of 5,500 feet is larger than a basketball court!

A 747 carries its own weather radar system. The on-board radar allows a pilot to detect a storm up to 300 miles away. The pilot can use the radar to study the storm and plot a safe course.

The Boeing 747 is equipped with two special navigational systems. The systems are self-contained and do not rely on outside radio or radar signals. This unique navigational equipment makes the jet's exact position available to the pilot at all times. When the special navigation equipment is connected to the autopilot, the system automatically steers the aircraft.


UNITED

3

AIRPORTS

An airport complex consists of runways, taxiways, terminal buildings, service areas, hangars, landing aids, and access roads. The aerial view of New York's La Guardia Airport on the opposite page shows all the parts that make up an airport.

At the top of the photograph, two of La Guardia's runways project on piles over the water of Flushing Bay. Hangars at the left- and right-hand edge of the photo flank the passenger terminal.

A huge five-level parking garage, which accommodates almost 3,000 cars, is in the foreground of the photo. Two passageways connect the parking facility with the central passenger terminal.

La Guardia Airport has a 150-foot-high control tower. The tower is located in the westernmost arcade of the passenger terminal at the left of the aerial photo. The control tower—designed in the shape of a flared urn—has twelve working levels.

The success of the airlines in the 1960s caused many problems on the ground: Airport facilities throughout the country were inadequate for the traffic. In the late 1960s, for example, Chicago's O'Hare Airport was handling 600,000 takeoffs and landings a year—more than one a

minute. Airports serving other major cities also found it difficult to accommodate all the aircraft landing and taking off. During periods of bad weather the problems multiplied. There were long delays on the ground and in the air!

New and larger airports were built throughout the United States to solve the problems of handling commercial flights. Most plans to avoid airport crowding recognize the need to establish a system of airports in and around major cities. New York City—a city hemmed in by other urban areas—has such a system.

The Port Authority of New York and New Jersey operates Newark Airport, Kennedy International Airport, and La Guardia Airport. Teterboro Airport in New Jersey, which is used for business and private aircraft, serves as a reliever airport. In other words, Teterboro is used to reduce congestion at the three primary airports. A second reliever airport is operated at Farmingdale, New York.

Newark Airport is located on 2,300 acres of land between the New Jersey Turnpike and U.S. Route 1. The basic plan of the airport can be seen in the aerial photo on the opposite page. The central passenger area consists of three terminal units. Three jet parking areas are attached to each terminal unit. Two of the terminal units with their six jet parking areas were in full operation when this photo was taken. Only two of the jet parking areas at the third terminal unit had been built at this time.

Runways are the areas on which airplanes make their takeoff roll. A runway is also the area on which a landing airplane touches down. The major runways at Newark Airport are clearly visible in the photo.

Note the two parallel runways just below the six jet parking areas at Newark. These runways stretch for 8,200

feet from left to right across the photo. Can you see that the right-hand end of each of these runways is marked with the number *22*?

A runway is marked to the nearest 10 degrees of the compass heading on which it is laid out. The last zero of the compass heading is omitted. Thus, the number *22* on a runway stands for a compass heading of 220 degrees. This means that a plane approaching these parallel runways from the right of the photo is on a heading of 220 degrees. The opposite ends of these runways are marked with the number *4*, designating a compass heading of 40 degrees.

There is a third runway at Newark Airport. This third runway, located at the right of the unfinished terminal unit, is numbered *29* at the one end and *11* at the other end. An airplane approaching this runway from the bottom of the photo is on a heading of 290 degrees.

4

AIR SAFETY

The control tower—standing high above all the other buildings—is an important center of activity at any airport. Rising 177 feet from airfield level, the control tower at Dulles International Airport—shown in the photo below—consists of a concrete shaft. Two stories in the upper section are used for radar and electronic equipment. The glass-enclosed room on top of the tower is called the *cab*.

Workers in the tower are called *air-traffic controllers*. It is their job to direct planes in and around the airport. Large panes of glass in the cab give air-traffic controllers an unobstructed view of the runways and field. The controller in the cab—shown in the photo on page 25—is giving directions to a pilot by radio. He is telling the pilot which runway to use.

An air-traffc controller clears the pilot for takeoff. The pilot heads the plane down the runway and into the wind. The engines roar as they thrust the plane forward. Slowly the air flowing past the wings lifts the plane from the ground. Then the pilot points the nose up to gain altitude.

A controller in the tower notes the time the plane took off. This information is sent to the Air Route Traffic Control Center in the area. There are twenty-one centers across the United States.

Each Air Traffic Control Center has a layout that is similar to the one shown in the photo on page 27. It is the job of the controllers at these centers to keep track of a plane from its takeoff to its landing. The controller shown in the photo on page 26 is using equipment that electronically writes an aircraft's altitude and identity on the radar display.

The fundamental element in air-traffic control is separation. This means that aircraft are separated laterally, longitudinally, and vertically. The lateral or side-by-side separation is maintained by routing aircraft over several parallel airways. The longitudinal or lengthwise separation on an airway is maintained by having a minimum flying time of ten minutes between an aircraft and the one following. Vertical separation is achieved by assigning different altitudes to aircraft on the same airway.

Below 18,000 feet, an aircraft on a heading between 0 degrees and 179 degrees is assigned an odd thousand-foot altitude. For example, an airplane flying eastward on a heading of 90 degrees may be assigned to an altitude of 5,000 feet. On the other hand, an aircraft flying on a heading of 180 degrees to 359 degrees is assigned an even thousand-foot altitude. This means that a plane moving

westward on a heading of 270 degrees could be assigned an altitude of 6,000 feet.

Above 18,000 feet, the same system of odd and even thousand-foot altitude assignments is used. The assigned altitudes above 18,000 feet are called *flight levels,* however. An altitude of 19,000 feet is referred to as *Flight Level 190.* An aircraft flying at 29,000 feet is at Flight Level 290.

Two sets of rules control the movement of all aircraft in the United States. These federal regulations are known as *Visual Flight Rules* (VFR) and *Instrument Flight Rules* (IFR). VFR means that the earth's surface is clearly visible and the pilot can fly the plane by referring to landmarks. When visibility is poor and weather conditions are producing problems, the pilot controls and directs the aircraft by referring to instruments within the cockpit. Under these conditions, the pilot uses IFR. The prevailing weather over most of the United States and the need to fly along designated airways limit VFR flying.

5

CARGO OPERATIONS

Cargo is the goods or merchandise carried in a ship, airplane, or other vehicle. The very first scheduled commercial airline flights were set up to carry mail. So cargo has been carried by air since airlines first began operating.

The carrying of cargo did not become a major part of commercial aviation until the 1950s, however. In fact, the first all-cargo air routes were established only in 1949.

Today the world's largest all-cargo airline is the Flying Tiger Line. The first cargo plane used by this company was the Budd Conestoga shown in the photo below. The first cargo carried by the Flying Tiger Line was a planeload of fresh grapes that was shipped from California to Georgia.

The Conestoga was an all-stainless-steel, rear-loading, twin-engine aircraft. It was capable of carrying 7,000 pounds of cargo over a distance of 500 miles. This rather

cumbersome-looking aircraft had a cruise speed of 150 miles per hour.

The Douglas C-47 shown in the photo above was the cargo version of the famed DC-3. The C-47 was a good reliable plane. Its performance as a cargo aircraft was better than the Budd Conestoga because it could carry 7,500 pounds of freight over a range of 600 miles at 150 miles per hour. An airline that used the C-47 had a slight competitive edge over one that used the Conestoga.

The C-54 was the first of the four-engine airfreighters. In the photo below, cargo is being moved into a C-54 along an airfreight dock at Burbank, California. Flying at 210 miles per hour, a C-54 could carry 20,000 pounds of cargo over a 2,000-mile range. In the late 1940s, a fleet of C-54s flew from the United States to Tokyo on an eight-flight-per-day schedule for almost a year to supply the American Occupation Forces in Japan.

The Lockheed Super H Constellation is shown above. This plane was put into service in 1957. It could airlift 43,000 pounds of freight at 300 miles per hour. The Super H Constellation had the first true coast-to-coast nonstop range of 2,500 miles. Transcontinental airfreight schedules were revolutionized by this plane.

The design of cargo aircraft evolved along with the growth of the freight business. And in 1961, the first turbine-powered airfreighter, Canadair CL-44, shown below, was placed in service. The CL-44's unique swing-tail design permitted straight-in loading of up to 65,000 pounds of freight. This airfreighter cruised at 375 miles per hour over a range of 3,000 miles.

The DC8-63 was the first of the jumbo-jet airfreighters. This sleek giant—shown at the top of the opposite page—carries a payload of 110,000 pounds at 550 miles per hour over a 3,000-mile range. Today major markets of the United States and Asia are linked by these huge airfreighters.

There is a continuing need for greater cargo capacity in world-wide airfreight operations. Wide-bodied aircraft like the Boeing 747 have large volume capacities. Boeing has built some 747s to carry freight.

The Flying Tiger Line uses some of Boeing's awesome giants to carry cargo to world-wide markets. The 747 air-freighter and its interior are shown below. This giant can carry 200,000 pounds of cargo at 575 miles per hour over a 3,500-mile range.

6

SUPERSONIC TRANSPORTS

Sound travels at about 760 miles an hour through the atmosphere. Aircraft that move faster than sound are said to be *supersonic*. Today supersonic transports—called *SSTs*—streak through the sky at more than twice the speed of sound.

The term *Mach number* is used to report the speed of an airplane. A Mach number is a measure of an aircraft's speed in relationship to the speed of sound. The speed of sound is given a Mach number of one.

An aircraft moving at twice the speed of sound is said to be flying at Mach 2. A Machmeter is shown in the lower photo on the opposite page. The Machmeter is in the passenger cabin of a Concorde—the first SST. The meter indicates that the plane is flying at Mach 2.04, which is more than twice the speed of sound.

The Concorde is shown in the upper photo. It can carry 108 passengers with a total payload of 25,000 pounds. Concorde burns somewhat less fuel to fly across the Atlantic Ocean than a 747, and it can fly over a range of 4,000 miles. The plane is designed to cruise at Mach 2. The altitude at which the Concorde normally flies is between 50,000 and 60,000 feet.

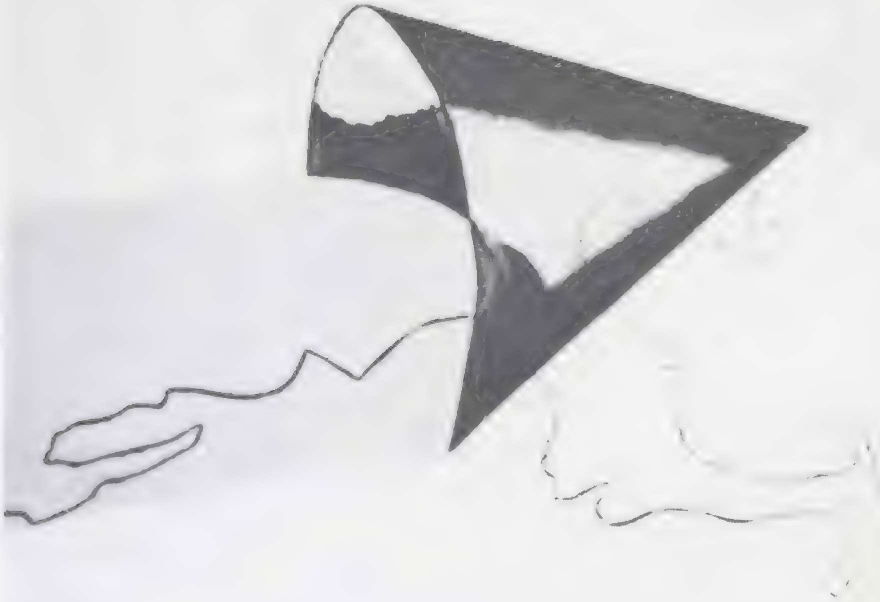

AIR FRANCE


EXIT
M2.04

The nose of the Concorde is lowered to improve the pilot's visibility at takeoff and landing. The Concorde's nose droop can be seen clearly in the photo below taken during a landing at Washington's Dulles Airport. Dulles Airport is sometimes referred to as "The Airport of the Future." It was designed to handle aircraft like the Concorde.

The wings of the Concorde have a very special shape. They are shaped like the Greek letter *delta*, which looks like a triangle. For this reason the Concorde is called a *delta-wing* SST.

A delta-shaped wing gives an SST some advantages. The large surface area of the wing produces a cushion of air



below it. The cushion of air makes it impossible to stall the plane while landing. And it allows the pilot to land the plane safely at relatively low speeds. The landing speed of the Concorde is about 180 miles per hour.

An SST can move faster than the speed of sound. When one does, it outraces its own sound and produces a boom. A sonic boom is simply a strong pressure wave. It is produced by two cones. One cone forms at the nose and the other forms at the tail of the SST. A boom carpet, shown in the picture above, spreads across the earth when the cones reach the ground. The width of Concorde's "boom carpet" is about 50 miles.

A sonic boom is not produced until an aircraft is flying faster than Mach 1, the speed of sound. Thus, at subsonic speeds Concorde is just like any other airliner and it makes no boom. This fact is used to control the boom produced by the Concorde.

On takeoff, the Concorde becomes airborne at a speed around 200 miles per hour. The takeoff speed, of course, depends on the aircraft's weight and how heavily it is

loaded. Thus the Concorde takes off and lands in a normal manner at low speeds that produce no boom.

The acceleration to supersonic speeds is delayed after takeoff until the plane is safely over the ocean and away from inland and coastal cities. When Concorde approaches a coastal area such as New York, for example, it decelerates to subsonic speeds. In fact, Concorde begins flying at low speeds over the ocean at least 100 miles from land. The subsonic speeds produce no booms.

At supersonic speeds a plane's skin gets hot. The heat is generated by the passage of air over the outer surface of the aircraft. A supersonic transport needs an air-conditioning system to maintain a comfortable temperature in the passenger cabin.

The Concorde has a specially designed air-conditioning system that maintains a uniform cabin temperature. During the landing descent at subsonic speeds, Concorde's skin cools down. The outer surface is not warm to the touch after the plane lands.

Supersonic transports can reduce the travel time between all major cities in the world. The Concorde travel time between New York and London is three and one-half hours. At present subsonic speeds, New York is seven hours from London. The trip from Los Angeles to Honolulu by subsonic jet takes just over five hours. The Concorde cuts this travel time in half. A trip from San Francisco to Melbourne, Australia, takes almost nineteen hours by subsonic jet. The Concorde puts San Francisco within nine and one-half hours of Melbourne.


AIR FRANCE

PART 2

Military Aircraft

The aircraft developed and used by our armed forces are the vehicles of aerial warfare. The function for which an aircraft is designed dictates its size, shape, speed, range, weight, and its operational altitude. Our armed forces have a need for many different kinds of aircraft.

The easiest way to classify military aircraft is by the job that they are designed to perform. There are, for example, aircraft used for training, observing, fighting, bombing, transporting, rescuing, and air refueling. In the sections that follow you will find some examples of modern military fighter, bomber, transport, and reconnaissance aircraft.

Another important part of military aviation is the development of new aircraft. It takes a lot of money, time, and patience to develop a new idea that eventually becomes an operational aircraft. In the next few pages you will find a description of three experimental aircraft that have been used to good advantage by our armed forces.

7

THE EXPERIMENTALS

The United States Government approved a Research Airplane Program in 1944. The first in the series of pure research aircraft, the X-1, was launched in 1946. The "X" in the name of the plane means *experimental.*

The X-15, shown in the photos, is a small rocket-powered aircraft. On June 8, 1959, the X-15 made its first flight after being dropped from the protective wing of a B-52. In a decade of flight that ended in 1969, the X-15 reached heights and speeds that are still unmatched by any other aircraft. The X-15, for example, reached a peak altitude of more than sixty-seven miles. And on October 3, 1967, an X-15 was flown at a speed of 4,520 miles per hour, which is the equivalent of Mach 6.7.

At heights of sixty-seven miles, the X-15 was traveling above the effective atmosphere. Thus, the X-15 collected information on flights in air and space. By flying to the frontiers of space, the X-15 tested the effects of weightlessness on human pilots. The X-15 research program also demonstrated the ability of human pilots to fly high-powered aircraft with great accuracy.


U.S. AIR FORCE
USAF
USAF


66670
USAF
X-15

Another research superplane, the XB-70, is shown taking off from Edwards Air Force Base in California. Two of these planes were developed and built for the Air Force. The XB-70's delta wing has a span of 105 feet. The fuselage is 185 feet long and 30 feet high.

The XB-70 has a long, pencil-like nose. Stubby horizontal stabilizers are located on each side of the plane just behind the cockpit. In the photo you can see the shadow cast by a stabilizer. The shadow reaches to and below the *E* in the word *FORCE*.

The delta wings of the XB-70 extend all the way to the tail section of the plane. Twin vertical stabilizers rise from the rear of the wings. Below the wings the exhaust pipes of the plane's six engines can be seen.

The XB-70 has a range of 7,500 miles. It was designed to fly above 70,000 feet at speeds of 2,000 miles per hour, which is equivalent to Mach 3. The plane was used extensively to study the stability, control, and handling characteristics of large supersonic aircraft.

The YF-12A is shown in the photo below. This plane is an experimental long-range interceptor that was nicknamed the Blackbird. It was developed for defense against supersonic bombers and airborne missile launchers. The Blackbird flies above 80,000 feet at a speed of Mach 3, which is more than 2,000 miles per hour.

The Air Force and the National Aeronautics and Space Administration (NASA) are using the YF-12A in a joint research program. An important part of the program is concerned with flight management and air-traffic control. The researchers are studying the ability of the plane to maintain a precise altitude at supersonic speeds.

8

RECONNAISSANCE

The original function of military aircraft was reconnaissance, that is, observation of enemy territory and positions to gather information. Most observation aircraft are of comparatively light weight and small size. They carry one or two observers and sufficient communication equipment to report their observations.

A Lockheed U-2 is shown in the photo on the opposite page. This aircraft is a subsonic turbojet that flies very-high-altitude reconnaissance missions. The plane is used by the National Aeronautics and Space Administration (NASA), the Central Intelligence Agency (CIA), and the United States Air Force (USAF). The wing size and its placement give the U-2 the appearance of a powered glider.

There is a large air intake at the wing root on each side of the plane. These air intakes make the U-2 look like a twin-engined plane. But both intakes feed into a single engine. The U-2 cruises at about 450 miles per hour. It has a maximum speed of 528 miles per hour.

The U-2 has a wingspan of 80 feet. The plane is almost 50 feet long and stands 13 feet high at the tail. It is a light airplane for its size and weighs less than 16,000 pounds at takeoff. The U-2 has a range of more than 4,000 miles, and it can operate at altitudes of 70,000 feet.

The U-2 was involved in a major international incident in 1960: On May 1, a U-2 operated by the Central Intelligence Agency entered Russian air space from the direction of West Pakistan. A Russian surface-to-air missile intercepted the U-2 at an altitude of 68,000 feet. The U-2 was shot down about 1,000 miles east of Moscow. This incident involving the U-2 was responsible for some difficult times in the United States-Russian relations during the early 1960s.

9

FIGHTERS

A modern fighter aircraft is smaller than a bomber or a transport. But it is far from being a small airplane. It must be large enough, for example, to carry sufficient fuel to accomplish its mission and return to its base. A modern fighter must also carry a heavy payload of cannon, air-to-air missiles, rockets, and guns.

A Lockheed F-104 Super Starfighter is shown in the photo on the next page. This plane has a speed of better than Mach 2. The Starfighter can operate at altitudes above 100,000 feet. An F-104 can climb as fast as it flies straight and level.

The F-104 has stubby knife-thin wings and a high T-shaped tail. From nose to tail the Starfighter measures 54 feet, 9 inches. It stands 13 feet, 6 inches high and has a wingspan of 21 feet, 11 inches.

Some F-104s are assigned to the Air Defense Command. These Starfighters are being used as air-defense fighters. This means that they are designed and equipped for attack against enemy bombers that are unprotected by enemy fighters. Thus, an air-defense fighter carries rockets. Radar equipment on board is used to find the enemy aircraft and aim the rockets at the incoming bombers.


FG-786
USAF
U.S. AIR FORCE

An F-111A is shown in the photo above. This plane is a tactical fighter. As a tactical fighter its mission may involve an air attack on enemy ground forces or positions. Such an aerial attack is often undertaken in close support of friendly ground forces.

The F-111 was developed by General Dynamics in 1964. Two basic models were put into service in 1967: the F-111A and the F-111B. The F-111A is used as a tactical fighter by the U. S. Air Force. The second model, the F-111B, is operated from the decks of aircraft carriers by the U. S. Navy.

Two other types of F-111s using the same basic design have been built: the RF-111A and the FB-111. The RF-111A is a reconnaissance fighter. And the FB-111 is a strategic bomber.

The F-111 is a variable-wing aircraft. This means that its wings can be moved into various positions. When a slow takeoff is desired, the wings are extended or placed in a position that is almost perpendicular to the fuselage. In flight, the variable-sweep wings can be folded or swept back into a triangular or delta configuration. The delta configuration is used when very high speeds are desired at both low- and high-flight altitudes.

The wings are usually extended during takeoff and landing. The extended or perpendicular position with a wingspan of 63 feet provides maximum lift. When the wings are extended, less than 3,000 feet of runway are required for takeoff and landing. The position of the wings shown in the photo of the F-111A is an intermediate angle between the perpendicular and the delta positions. In the delta position, the wingspan is a mere 32 feet.

The F-111 is a 72-foot-long supersonic aircraft. It has a maximum speed of Mach 2.5 at 60,000 feet. The F-111 has a range of 5,000 miles without refueling. This means that it can be sent on transoceanic missions. In addition, however, this aircraft is equipped so it can be refueled in flight.

The F-111 is equipped to carry both conventional and nuclear weapons. Its armament includes air-to-air missiles, air-to-ground missiles, and rockets.

10

BOMBERS

Modern bomber aircraft are streamlined giants. They are equipped with the best jet engines, which produce speeds that compare favorably with fighter aircraft. Bombers normally have extensive ranges. And when a bomber is equipped for aerial refueling, it has a virtually unlimited range.

The Boeing B-52 Stratofortress is the last of the so-called "conventional bombers." The first B-52 was flown in April 1952. The last Stratofortress came off the production line in 1962.

The B-52 was designed as a nuclear bomber. Its belly is divided into two separate bomb bays to carry two nuclear weapons. As many as twelve Short Range Attack Missiles (SRAM) can be carried externally under the wings.

The last of the B-52s built has a wingspan of 185 feet. From nose to tail, the plane is 160 feet long. The B-52 is

powered by eight jet engines that push it through the air at 650 miles per hour. Its unrefueled range is more than 10,000 miles, and the plane normally flies above 50,000 feet.

The Stratofortress carries a crew of six. There are two pilots, a navigator, a radar bombardier, an electronic countermeasures officer, and a fire-control director who sits in the forward section of the aircraft. The tail guns are trained through the use of radar that is mounted in the tail.

A Convair B-58 Hustler is shown above in the process of completing an aerial refueling. The B-58 is a Mach 2 bomber that was first flown on November 11, 1956. The Hustler was the first supersonic bomber in the world.

The B-58 with an overall length of 97 feet is much shorter than the B-52. The B-58's delta wing spans almost 57 feet. The delta-wing design of the B-58 requires that all takeoffs and landings be made at high speeds. The takeoff speed of a B-58 is often above 230 miles per hour. Its landing speed is as high as 190 miles per hour.

The B-58 shown above carries a three-man crew consisting of the aircraft commander, bombardier navigator, and the defense-systems operator. The entire wing and most of the fuselage behind the cockpit are used to store more than fifty tons of fuel. The weapons payload—18,000 pounds of bombs—is carried beneath the aircraft in a long pod. The pod can be seen in the photo; it is numbered B-1105.

A photo of the B-1 strategic bomber is shown on page 53. This aircraft was developed by the Air Force to modernize its bomber fleet. The first flight of a B-1 took place on December 23, 1974. A rather extensive flight test program was developed by the Air Force for the B-1.

The B-1 is a variable-wing bomber. In the extended or forward position the wingspan is 135 feet. In the folded or swept-back position the wingspan is 78 feet. The swing wing allows the B-1 to perform efficiently at low and high speeds.

At low, slow speeds a straight wing is much more efficient than a swept wing. During takeoffs, landings, airborne loiter, and aerial refueling there is a distinct advantage to being able to place the B-1's wings in a straight or forward position.

Four powerful jet engines give the 150-foot-long B-1 a top speed of Mach 2.1, which is approximately 1,350 miles per hour. For high-speed supersonic flight at both low-level and high altitudes, there is a definite advantage to having the wings in a swept position.

11

TRANSPORTS

A military air transport is an aircraft designed for the movement of cargo and passengers. Transports usually have the capability of being modified so they can be used for special missions. For example, the photo below shows the interior of a C-141 modified to provide litters, oxygen equipment, and the facilities necessary for the air evacuation of wounded.

A Lockheed C-141 Starlifter is shown in the photo on the opposite page. The Military Airlift Command began using these planes in 1963. The C-141 has a maximum takeoff weight of around 320,000 pounds. Today the C-141 is used primarily for carrying troops.

The C-141 has a 145-foot fuselage. It has a wingspan of 160 feet. The T-tail stands 39 feet high. The C-141 has four fanjet engines. Each of the engines develops 21,000 pounds of thrust, which allow the C-141 to cruise at more than 500 miles per hour.

The C-141 can carry troops in airline-type seats. Study the photo of the C-141 interior on the opposite page. There are seven rows of airline-type seats behind the litters.

The C-141 was the first pure jet aircraft specifically designed and built to meet military standards as a troop and cargo carrier. This four-engine, T-tailed jet regularly flies nonstop from Dover Air Foce Base in Delaware to Germany. It can fly nonstop from San Francisco to Tokyo.

The gigantic C-5 Galaxy, put into service in 1970, is modeled after the C-141. But it is much larger than the C-141. The C-5, for example, has a maximum takeoff weight of 760,000 pounds. This is almost two and one-half times greater than the C-141's takeoff weight.

The C-5 is just about 248 feet long. It has a wingspan of almost 223 feet. The T-tail of the C-5 reaches 65 feet into the air.

The C-5 has unique front and rear cargo openings. The visor-nose opening at the front of the plane can be seen in the lower photo on the opposite page. The cargo compartment is 121 feet long, 13.5 feet high, and 19 feet wide. The C-5's cargo floor area is triple that of the C-141 Starlifter. And the volume of the C-5's cargo hold is four and one-half times larger than that of the C-141.

The C-5 does not carry troops in the cargo compartment. The second story or upper deck, however, has seventy-three seats that are in a rear compartment. Drivers and operators of equipment being airlifted use the seats available in the rear compartment on the upper deck. The forward compartment on the upper deck has accommodations for a six-man crew, a six-man relief crew, and eight couriers. The flight deck, of course, has the work stations for the crew.

Four jet engines are mounted on pylons beneath the wing. The average cruise speed of the C-5 is 520 miles per hour. The Galaxy flies above 35,000 feet and has a range of 6,300 miles with 100,000 pounds of cargo. The maximum load it can carry is 255,000 pounds.


U S AIR FORCE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PART 3

Special Aircraft

The traditional purpose of aircraft has been to provide a means of transportation for people and cargo. In this third section, you will read about helicopters, VTOLs, and the space shuttle program. Each of these machines is designed to accomplish the task of transporting people and cargo in a very special way.

Many agencies of government are beginning to find that their missions can best be accomplished by the use of aircraft. The National Oceanic and Atmospheric Administration, a branch of the United States Department of Commerce, for example, has found that specially outfitted aircraft can provide valuable information about the atmosphere and the ocean. In addition, specially equipped research aircraft are being used by the National Aeronautics and Space Administration to make surveys of the Earth's surface and objects in space.

Private companies are finding that aircraft can help them in their tasks, too. The Zapata Corporation, for example, is a company that uses modern technology to good advantage. They have found a very important use for a specially equipped light plane.

12

HELICOPTERS

Most helicopters flying today use simple rotating blades to get lift and control. A main rotating blade lifts the craft. The small blade at the tail helps the pilot to move the helicopter in different directions.

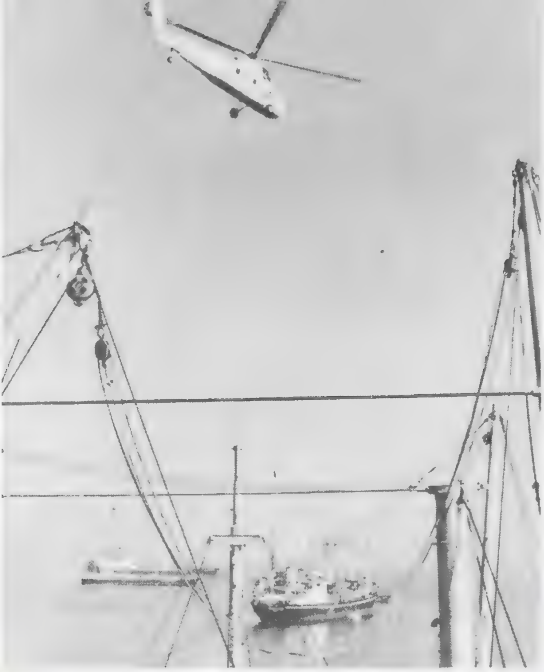
The tail blade does something else, too. It balances the twisting forces of the main blade. Without the tail blade the cabin of the helicopter would spin like a top.

Sikorsky Aircraft's ABC helicopter is shown in the photo below. The ABC does not have a tail blade. It has two main blades. One is placed above the other. These blades rotate in opposite directions. They balance each other and the cabin does not spin.

The ABC in the photo is flying over the Connecticut countryside. The tail with movable parts allows the pilot to change direction. This new tail feature gives the pilot greater control of the craft and offers improved maneuverability.

Sikorsky Aircraft's twin-turbine-powered S-76 shown above has a four-blade main rotor. No wheels can be seen in the photo. The wheels are retractable. The S-76 carries up to twelve passengers plus a crew of two. It has a maximum cruise speed of 179 miles per hour and a range of 460 miles.

The instrument panel of the S-76 is shown below. IFR equipment is installed. The S-76 is equipped with communication and navigation aids for all-weather operation.



The Sikorsky S-58T—shown in the photos on this page—is a medium-lift helicopter. The S-58T above is heading for a drop zone on the shore in Jeddah, Saudi Arabia. The helicopter is carrying a load of cement from one of the ships waiting in the harbor. Helicopter unloading is being used because Jeddah's dock facilities are not adequate for the amount of shipping coming into the port.

The Sikorsky S-61 can carry thirty passengers plus its crew. This helicopter has a cruise speed of 140 miles per hour and a range of about 500 miles. Okanagan Helicopters in Canada and New York Airways in the United States put the S-61 to good use in passenger service.

The S-61 gives good reliable service. One of these transport helicopters operated by the Evergreen Company is shown landing on a drilling rig in the Gulf of Alaska. High winds, heavy seas, ice, rain, and snow are constant threats to operations in these waters.

13

STRAIGHT UP AND AWAY

The length of a runway limits the kinds of planes that can land at an airport. Airlines have been searching for ways to get around this problem. One answer is to use aircraft that can take off and land vertically.

The vertical takeoff and landing machines are known as VTOL airplanes. A VTOL does not need a runway. It can hover like a helicopter. And it can fly like a regular airplane.

The X-22A is a VTOL aircraft. It has four huge ducted fans. Four jet engines provide the power to drive the seven-foot-diameter propellers. The fans can be tilted. They can be tilted vertically or horizontally.

During takeoff the fans of the X-22A are tilted vertically. The thrust is directed downward. The downward thrust causes the plane to be lifted straight up.

As the X-22A rises, the pilot begins tilting the fans horizontally. In the photograph on the opposite page, the fans are being tilted from a vertical to a horizontal position. The plane moves forward with the fans in a horizontal position.

The X-22A basically is a research craft. It is 40 feet long and 20 feet high. The X-22A has two wings. A fan is fixed to the end of each wing. The long wing—located just forward of the vertical stabilizer—has a span of 39 feet. The shorter wing is mounted just behind the cockpit.

The Vertol 76 shown above is a VTOL that has a tilt-wing. With the wings in the position shown in the photograph, the propellers are used as rotary wings for takeoff. The wings and engines tilt to a horizontal position to provide thrust and lift for conventional flight.

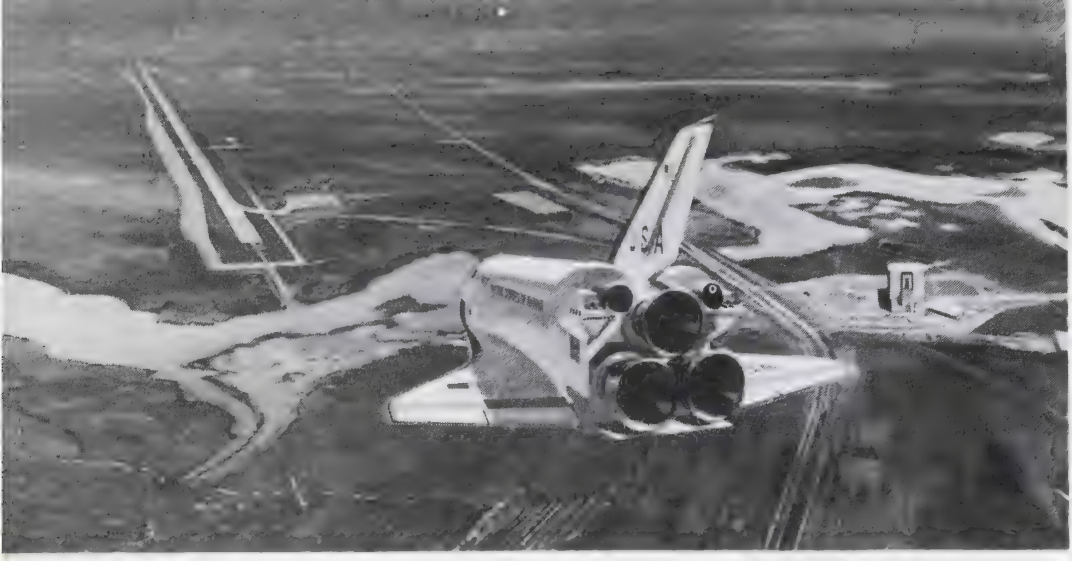
The Hawker Siddeley Harrier shown below is a British fighter used by the Royal Air Force. It has a speed of Mach 1.25 and operates above 50,000 feet. The Harrier looks like a regular jet but it is a VTOL. There is a thrust-deflection nozzle inside its engine. The nozzle is used to direct the exhaust power of its engine downward for takeoff and landing and to the rear for horizontal flight.

14

SPACE SHUTTLE

The space-shuttle orbiter *Enterprise* left the ground for the first time on the morning of February 18, 1977. The craft shown below was riding piggyback atop a modified Boeing 747. This first flight lasted two and one-half hours. The 747 carried the shuttle to a height of 16,000 feet to test the stability of the vehicle.

The shuttle is a true space-transportation system. It consists of two stages: a booster for launch from earth, and an airplane-like manned reusable orbiter for flight into space where it will conduct its missions. The orbiter is designed to be flown back to the earth and to land at a conventionally sized airstrip.

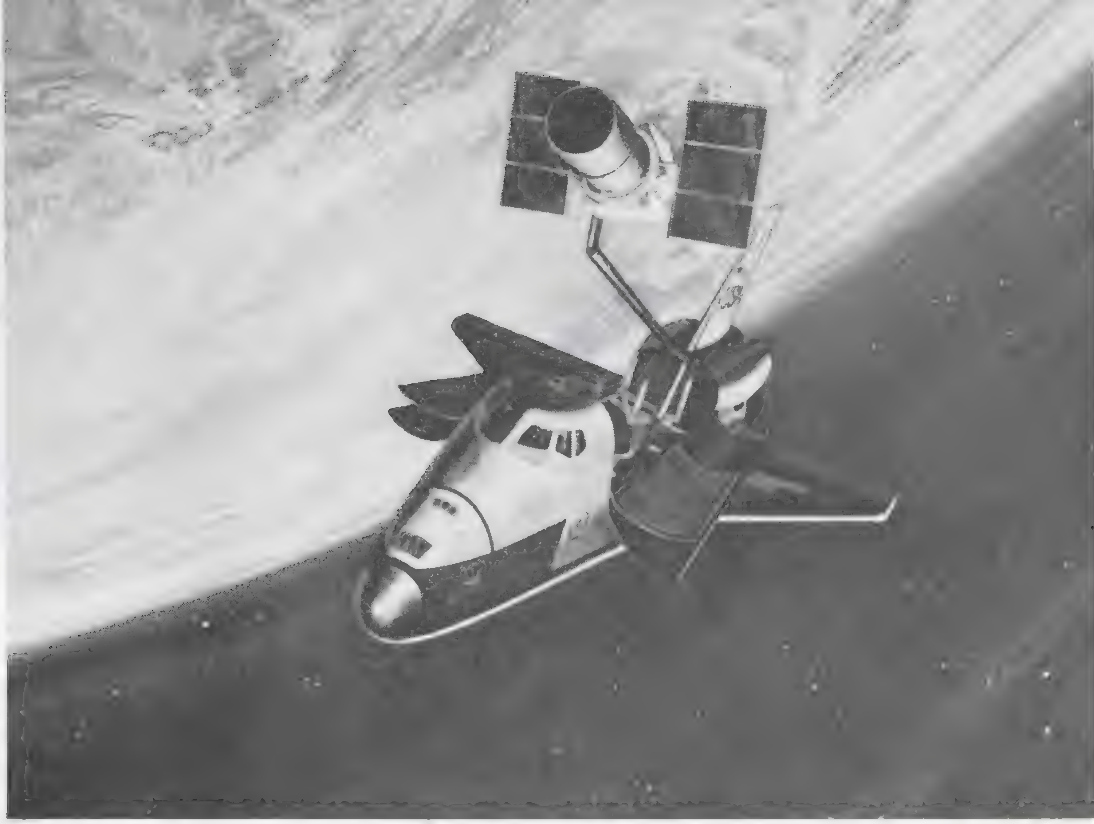


The shuttle will lift off vertically as shown in the lower picture on the opposite page. Two solid-propellant booster rockets will fire in parallel with three liquid-propelled rocket engines of the orbiter. After burnout, the solid rocket will be jettisoned and parachuted to the ocean where it will be recovered.

The orbiter is equipped with a delta wing. A crew of four is responsible for the operation of the orbiter. The orbiter's cargo compartment is 15 feet in diameter and 60 feet long. This craft will carry payloads of 65,000 pounds into space. The payload can consist of either people or cargo.

The orbiter will make space operations less complex and less costly. It will also encourage greater participation in space flight. Scientists and engineers, for example, will be able to go into orbit to check on their experiments. In the upper picture opposite, the manipulator arm of the orbiter is extended to retrieve a satellite.

When the orbiter completes a mission in space, its pilots will fire its rockets to slow it down. Then they will direct the orbiter so it re-enters the earth's atmosphere. The orbiter will be flown through the atmosphere and landed like an airplane on a jet-sized airstrip. Each orbiter is designed to be reused up to a hundred times.



15

WEATHER RECONNAISSANCE

In the Atlantic Ocean, the job of flying into the most violent weather in the world is assigned to flying weathermen of the U. S. Air Force. These men are known as *hurricane hunters*. They fly Lockheed WC-130 Hercules aircraft.

The WC-130 shown in the photograph is on the ground at Ramey Air Force Base in Puerto Rico. The aircraft is a four-engine turboprop that can cruise at 350 miles per hour. The "W" denotes that it has been weather modified. This means that it is packed with special weather instruments.

Data for altitudes below the flight level are obtained by an instrument called a *dropsonde*, which is a collection of weather-sensing instruments in a small case. The dropsonde being prepared in the lower photo opposite will be dropped from the WC-130 by parachute. The instrument readings are radioed back to the aircraft by a small transmitter in the dropsonde.

The WP-3D Orion shown above is a weather plane operated by the National Oceanic and Atmospheric Administration. Special weather-radar units are housed in its nose, in the large black blister below the fuselage, and in the tail. The WP-3D operates effectively from sea level to 30,000 feet. It can loiter at speeds between 200 and 260 miles per hour. Top speed for the WP-3D is about 460 miles per hour.

16

EARTH AND SKY SURVEY

A variety of aircraft have been modified and are used by governmental agencies and private corporations to make observations of the land, ocean, and sky. A broad range of photographic and other sensing equipment is carried by these survey aircraft. The altitude at which the survey is to be made determines the kind of aircraft that is used.

U-2s and WB-57Fs are used by NASA and the Air Force for high-altitude surveys. A WB-57F is shown in the photo on the opposite page. It flies survey missions at 60,000 feet and above. This high-altitude aircraft is equipped with a variety of long- and short-focal-length camera systems.

A high-altitude aerial photograph of the New York metropolitan region is shown on the opposite page. This photo was taken by a NASA aircraft. The river at the upper left of the photo is the Passaic River. The Passaic flows through the city of Newark, New Jersey. The Hackensack River is to the right of the Passaic River in the photo. The Passaic and the Hackensack rivers flow into Newark Bay. The cities of Bayonne and Jersey City are on the peninsula that borders Newark Bay. Manhattan Island has the Hudson River on its left and the East River on its right. The Hudson and East rivers flow into Upper New York Bay. The island in Upper New York Bay off the tip of Manhat-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tan is Governor's Island. The bridge in the lower left of the photo is the Verrazano Bridge, which runs from Staten Island on the left to Brooklyn on the right.

The Lockheed C-130 Hercules, which is used by the Air Force in weather reconnaissance, is a very versatile plane. The C-130 shown above has been modified by NASA for use in its survey program. This plane, called *Earth Survey 2*, flies medium-altitude missions.

The Lockheed Starlifter shown in the upper photo on the opposite page has been modified by NASA to carry an infrared telescope. The C-141 is cruising with its telescope port open. The high-flying telescope allows astronomical observations that are not possible at the earth's surface.

The Zapata Corporation conducts aerial fishery surveys with two Cessna Skymaster 337 aircraft. A special low-light-level camera is mounted in the pod beneath the fuselage. The plane in the lower photo on page 75 is flying along the Pacific Coast of Baja California. The aircraft is used to assist anchovy fishing vessels.

ILLUSTRATION CREDITS

Air France: pp. 33, 34, 37
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North American Rockwell: p. 41
Pan American World Airways: p. 8 (middle)
Port Authority of New York and New Jersey: pp. 20, 23
Sikorsky Aircraft: pp. 60, 61, 62, 63
Trans World Airlines: pp. 8, 16 (lower right), 19 (middle)
United Airlines: pp. 2, 10, 11, 12, 13, 14, 15, 16 (lower left), 17, 19 (upper and lower)
U. S. Air Force: pp. 42, 43, 47, 48, 50, 51, 52, 53, 54, 55, 57, 70, 71
Zapata Corporation: p. 75 (lower)

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JOHN GABRIEL NAVARRA, the author of *SUPERPLANES,* is professor of geoscience and was for ten years chairman of the division of science at Jersey City State College. As both a teacher and a writer, Dr. Navarra has an international reputation. He was the teacher of the first televised science course to be offered in the South when he was on the faculty of East Carolina University. He has written a number of trade books for young readers, adult science books, college textbooks, and is the senior author of a complete series of science books, grades kindergarten through nine, that are used by millions of school children throughout the United States. Dr. Navarra served in the Air Force during the 1940s. During the last thirty-five years he has maintained a lively interest in the new developments in flight. He has flown more than one million miles on aircraft of every description—including flights on DC-3s through the Himalaya Mountains and on Boeing 747s over the South Pacific Ocean to Australia.

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Roy Doty with Leonard Maar

WHERE ARE YOU GOING WITH THAT ENERGY?
Roy Doty with Leonard Maar

UP, DOWN AND AROUND
Millicent Selsam